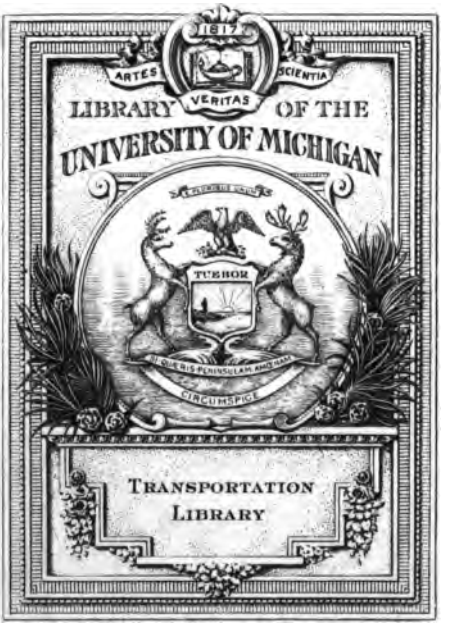

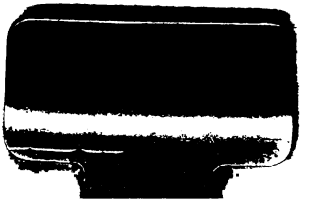

HOW OIL IS USED FOR FUEL ON LOCOMOTIVES.

SUPPLEMENT TO

THE SCIENCE OF RAILWAYS

BY

MARSHALL MONROE KIRKMAN.

PUBLISHED BY

THE WORLD RAILWAY PUBLISHING COMPANY.

NEW YORK AND CHICAGO:
THE WORLD RAILWAY PUBLISHING COMPANY.
1902.

THE HENNEBERRY CO., PRINTERS, CHICAGO.

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HOW OIL IS USED FOR FUEL ON LOCOMOTIVES.

WHAT FUEL OIL IS AND HOW OBTAINED.

Fuel oil, as it is commonly called in America, is known to the commerce of the world as Petroleum, a word coined from two latin terms *petra* a rock and *oleum* oil, and which accurately describes the liquid which is found in the earth naturally in many parts of the globe and is believed to be formed by the gradual decomposition of vegetable matter beneath the surface.

The oil varies much in color and consistency in different localities. In some places it is of a faint yellow color thin and almost transparent; in others of a brownish black color sometimes as thick as molasses. It is found in most European countries and in the United States; it has been for many years abundant in Pennsylvania, New York, Ohio and Indiana, and latterly has been found in large quantities in the States of California and Texas.

Generally speaking, the oil is brought to the surface by means of pumping from wells; in some instances, however, the supply is so abundant that the wells have a natural flow; sometimes also it is found oozing from the crevices of rocks or floating on the surface of water.

The existence of petroleum has been known in the states of New York and Pennsylvania from

the earliest Colonial days. It was not till the year 1859, however, that it began to be of commercial importance in America; in that year wells began to be systematically bored. The product of the oil fields of New York and Pennsylvania has been and is, utilized principally as an illuminant, the crude oil being for that purpose refined and marketed in the form of Kerosene. This industry has grown to enormous proportions, not only supplying America with sufficient for home consumption, but exporting a vast quantity annually to all parts of the world.

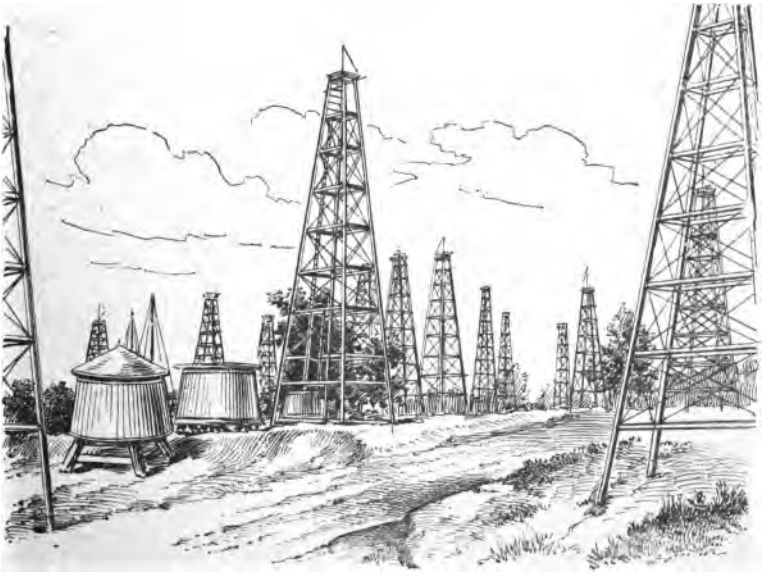


FIG. 1.

OIL FIELDS.

THE USE OF OIL AS FUEL—ITS ADVANTAGES UNDER FAVORABLE CONDITIONS.

The use of oil as fuel is no new thing; it can be traced to the times of remote antiquity. Its scientific adoption to industrial purposes commenced, however, not earlier than about the year 1860. In 1870 it was used during the great siege of Paris in France when the city's supply of coal had been exhausted and we are told it was the means of enabling the city to keep several of its large factories going and to grind its flour by steam while it was begirt by its enemies.

Conditions will have to change very much before oil can come into general use as fuel for industrial purposes by reason of its greater cost at present as compared with that universal fuel, coal. In favored countries or districts, however, where the supply is plenteous and close at hand, or where coal is more remote and the difficulty of cost does not stand in the way of its economical use, it seems certain that oil will be more and more used because the mechanical difficulties attending its use are one by one being overcome. More than a decade ago in the Caspian region where petroleum is plentiful the apparatus for its consumption had been measurably perfected and oil for fuel had replaced wood and coal on all the steamers plying on the Caspian Sea and on the locomotives of the Trans-Caucasian Railway as well as in the furnaces and factories of that district.

With the discovery of new sources of oil supply in America its availability as fuel on loco-

motives has become general in certain districts, and it is not unreasonable to suppose that further supplies will be found and the field for its use be correspondingly enlarged, so that the subject has become, and will be in the future, of great interest to those concerned with the motive power of our railroads.*

Petroleum as a fuel for locomotives is said, apart from the economic question of cost, to be infinitely superior to coal: It is smokeless; free from dirt and dust; can be instantly lighted; requires no stoking; can be regulated instantly and easily; requires much less storage room, and its calorific power for purposes of generating steam is several times greater than that of ordinary coal. There are, in fact, many things to be said in its favor for this purpose but few against it: While it is true that its use reduces the life of the flues and firebox about twenty-five per cent yet, on the other hand, it emits no sparks to cause conflagrations along the right of way or set fire to stations, buildings, or equipment; the cost of handling it is at least seventy-five per cent less than coal; no clinkers have to be removed at terminals or on the road; its use reduces the time consumed in turning the engine; it makes no refuse or cinders to be taken care of; it insures freeer steaming and freeer running loco-

*In the United States it is said that oil for locomotive fuel at $1.00 per barrel is an economical equivalent of coal at $4.00 per ton. At some points where oil is now obtainable at the price mentioned coal costs from $7.00 to $8.00 per ton. Its great economic value under such circumstances is apparent.

motives and consequently affords greater ability to handle maximum loads; furnishing a uniform grade of fuel, it becomes practicable to adjust draft appliances so as to get the best results under all conditions; owing to the easy and exact regulation of the fire possible, the greatest economy in firing is possible, as the labor of firing coal conduces to extravagance in its use; and, finally, the fuel supply can be taken at stations simultaneously with water very rapidly and without waste.

STORAGE.

In the practical operation of railways, after the oil has been taken from the earth it is necessary to store it in reservoirs from which it is conveyed to supply or delivery tanks; an illustration showing the kind of tanks used and their location in relation to the water supply is shown in Fig. 2.

These supply tanks are often located opposite the water tanks so that fuel and water can be taken simultaneously. In the construction of these tanks it is generally necessary to make provision for heating their contents so as to insure the oil flowing freely in cold weather. The accompanying illustration (Fig. 3) shows the details of the construction of a supply or delivery tank.

SPECIAL ADAPTATION OF LOCOMOTIVES—THE TENDER.

Locomotives on which oil is used for fuel must be specially adapted for the purpose. From the

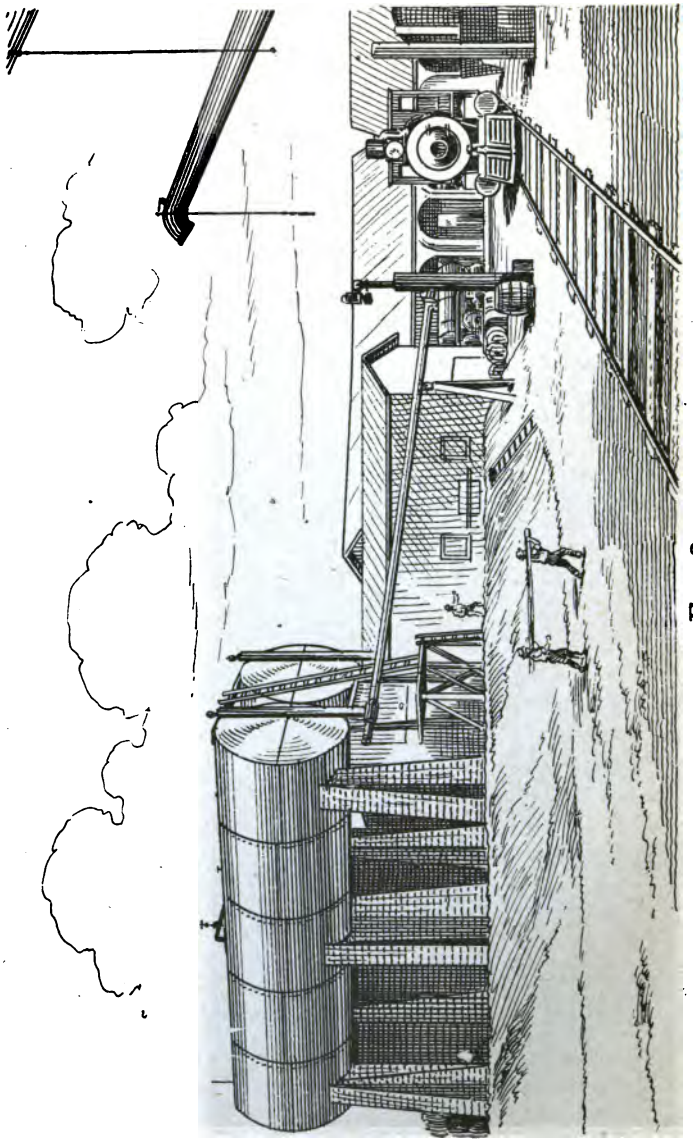


FIG. 2.
OIL AND WATER STATION.

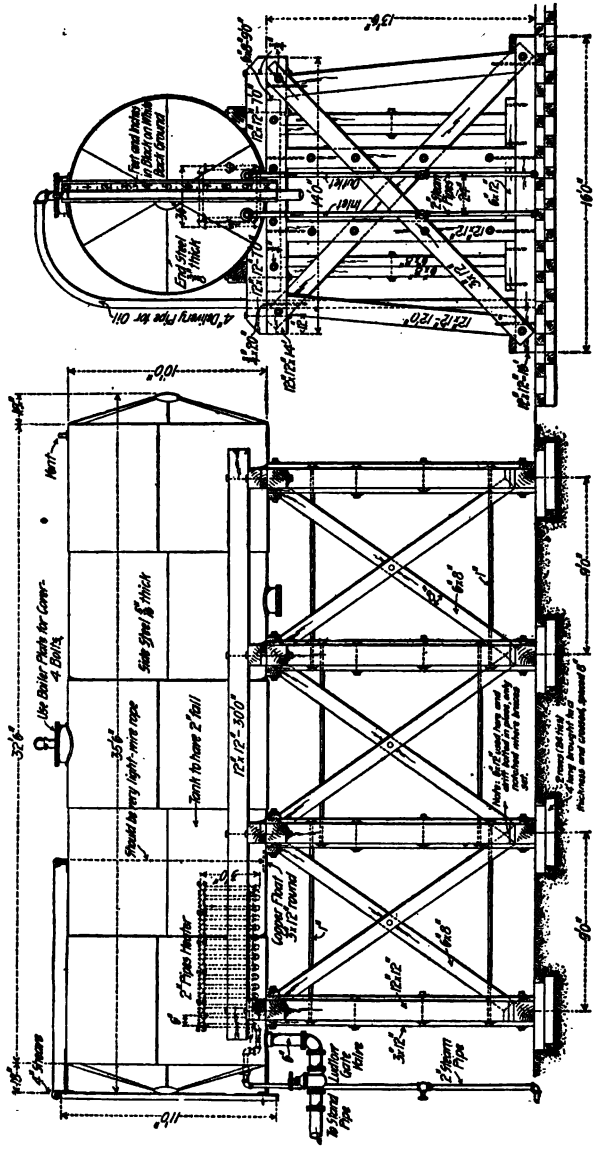


FIG. 3.

DETAILS OF CONSTRUCTION OF SUPPLY OR DELIVERY TANK.

delivery or supply tank the oil is conveyed to a tank in the tender which is generally a separate receptacle fitted in the space ordinarily used for coal. The arrangement of the tender is indicated in the following illustrations. Figure 4 shows the outside appearance of a tender equipped for oil burning.

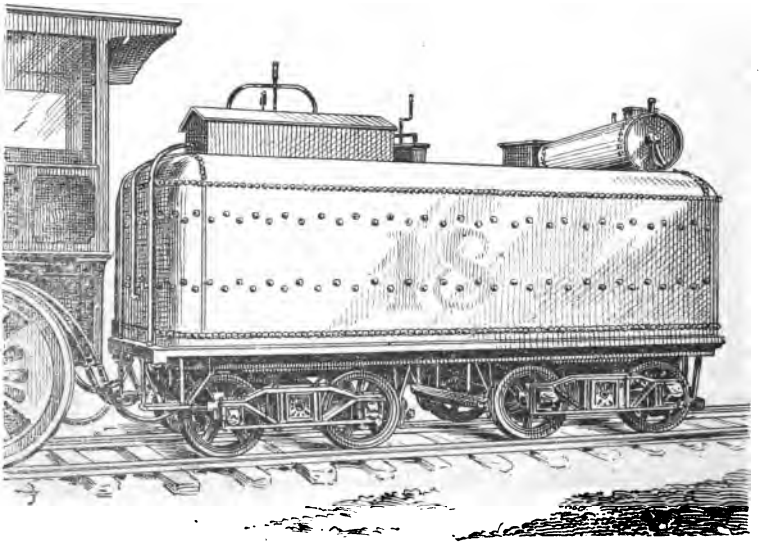
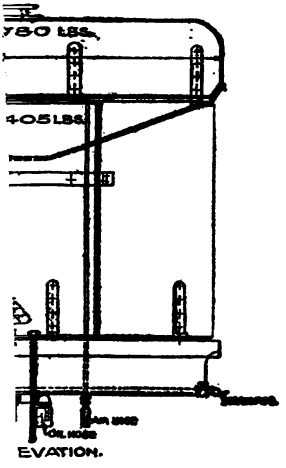
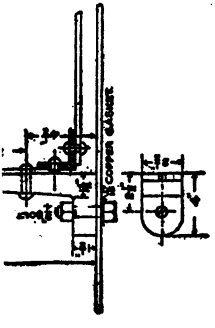


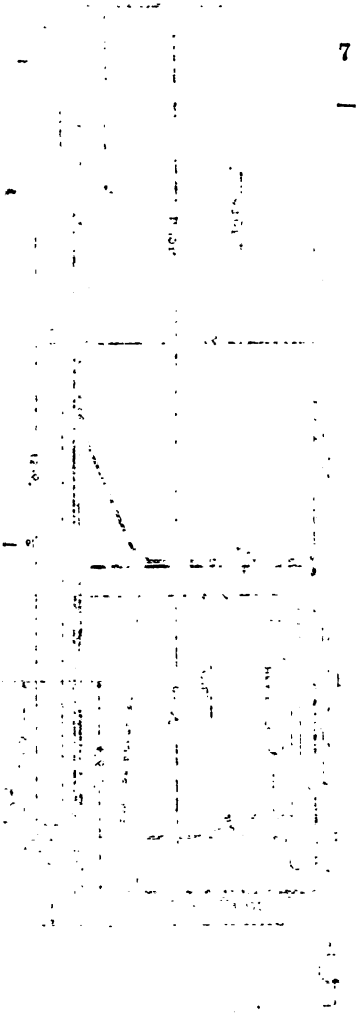
FIG. 4.

APPEARANCE OF TENDER EQUIPPED FOR OIL BURNING.

Figure 5 shows the details of the tender equipment as used on the Southern Pacific Railway.







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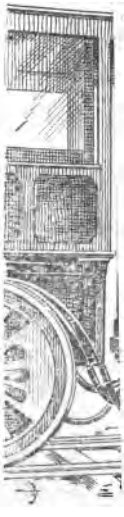

APP

Fig
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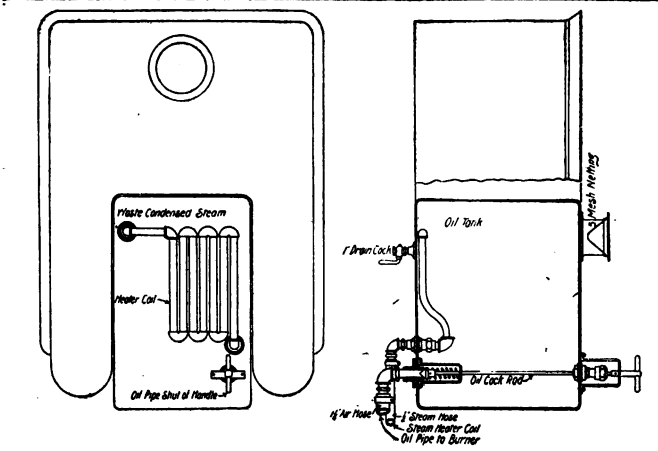


FIG. 5.

DETAILS OF TENDER EQUIPMENT—SOUTHERN PACIFIC.

Figure 6 shows the arrangement of piping on the tender as adopted by the Santa Fe system.

THE HEATER COIL IN TENDER.

As in the case of the supply or delivery tank so also the oil tank on the engine tender must be provided with a heater coil to which in cold weather steam can be admitted from the boiler so as to reduce the oil to a proper consistency. This heater coil is illustrated by Fig. No. 7.

THE PIPING AND APPLIANCES ON TENDER AND ENGINE.

The oil tanks in the engine tender are fitted with automatic safety valves with a small chain or rope connection to the back of the engine cab

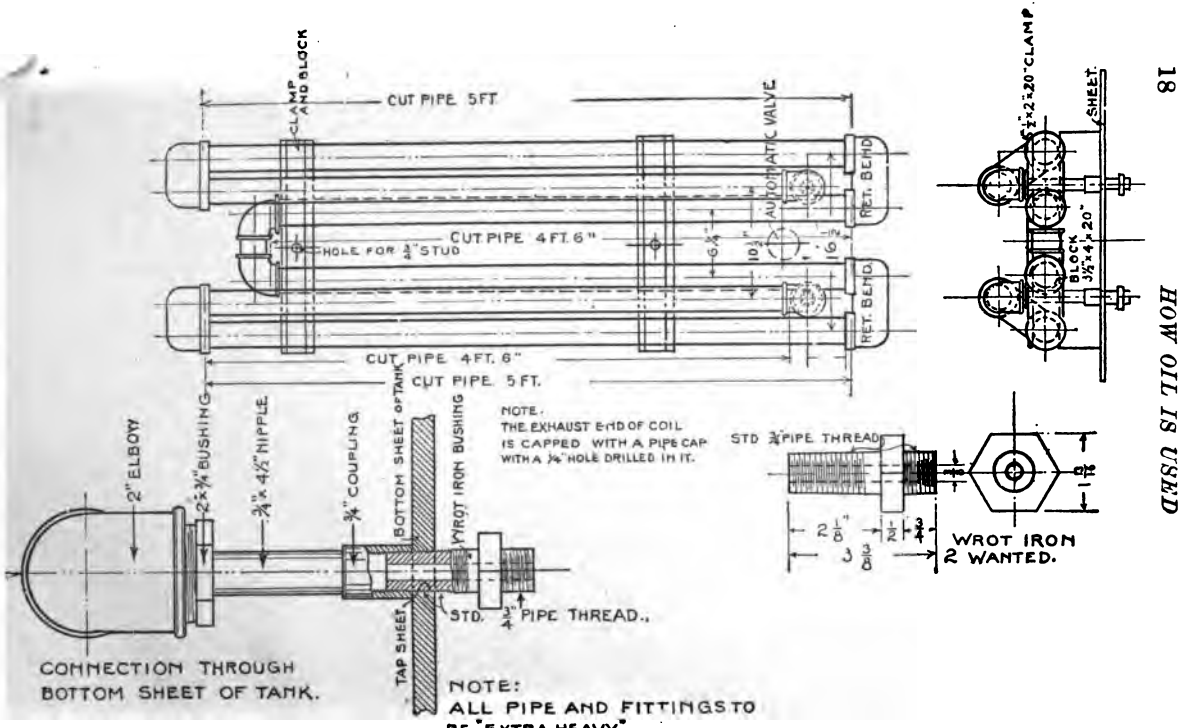


FIG. 7.

HEATER COIL—SANTA FE.

with a spring key which passes through the upright rod of the safety valve so that in case the engine breaks apart from the tender the rope or chain will pull the spring key out of the rod when the safety valve will close automatically and stop the flow of oil from the tank.

The following illustrations, Figures 8, 9, 10 and 11 indicate the details of the piping on the tender, the safety valve, the delivery pipe and fittings and the hose and fittings as used on the Santa Fe system.

In localities where heavy oil is used it is necessary to carry about five pounds pressure in the tender oil tanks to facilitate the proper flow of the oil. With light gravity oil, however, and in warm weather such pressure is not necessary. The illustration, Fig. 12, shows very clearly the general arrangement of an oil burning locomotive.

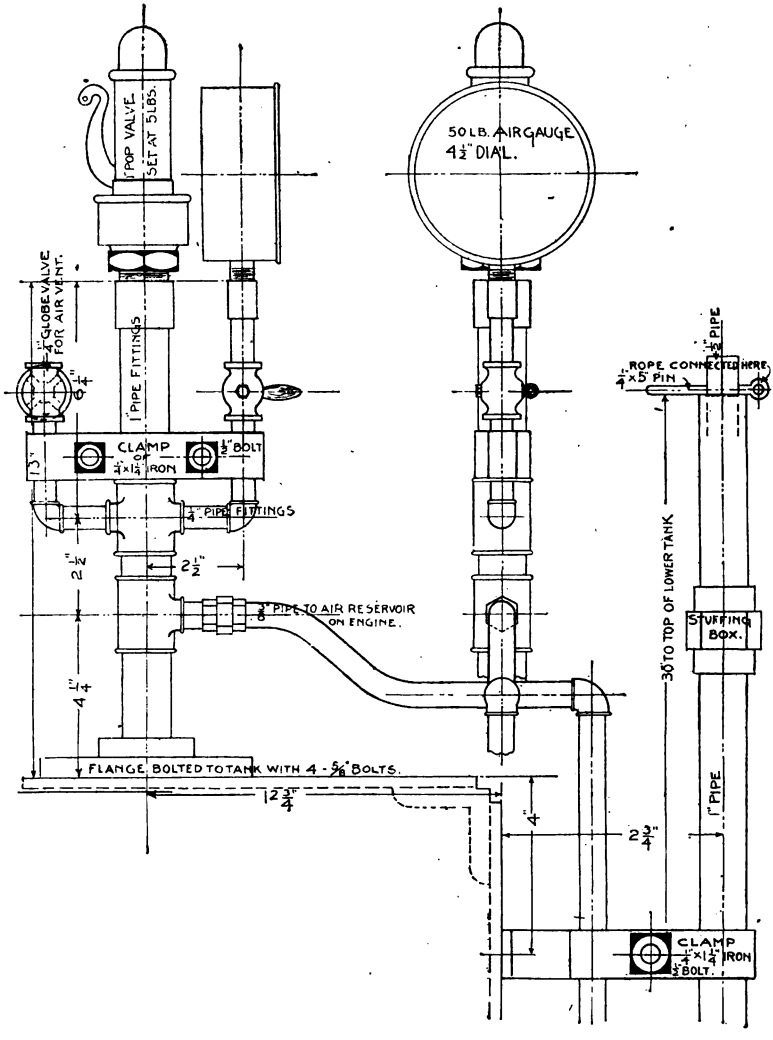


FIG. 8.

DETAILS OF PIPING ON TENDER—SANTA FE.

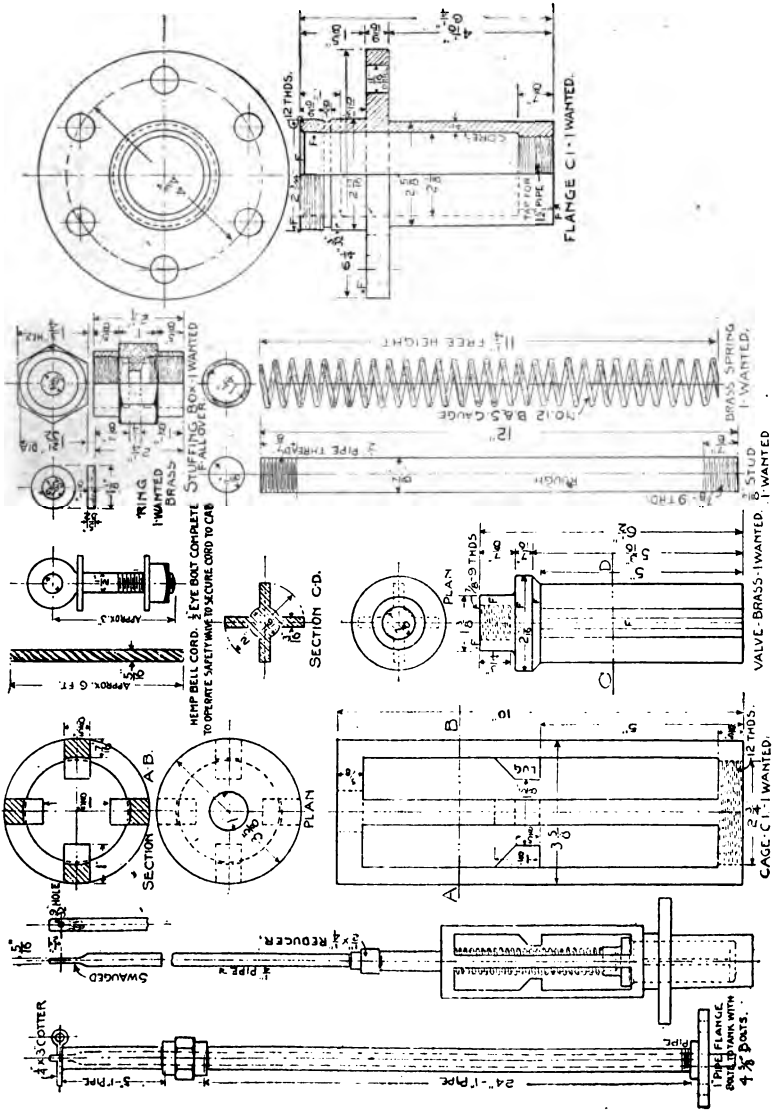


FIG. 9.

DETAILS OF SAFETY VALVE—SANTA FE.

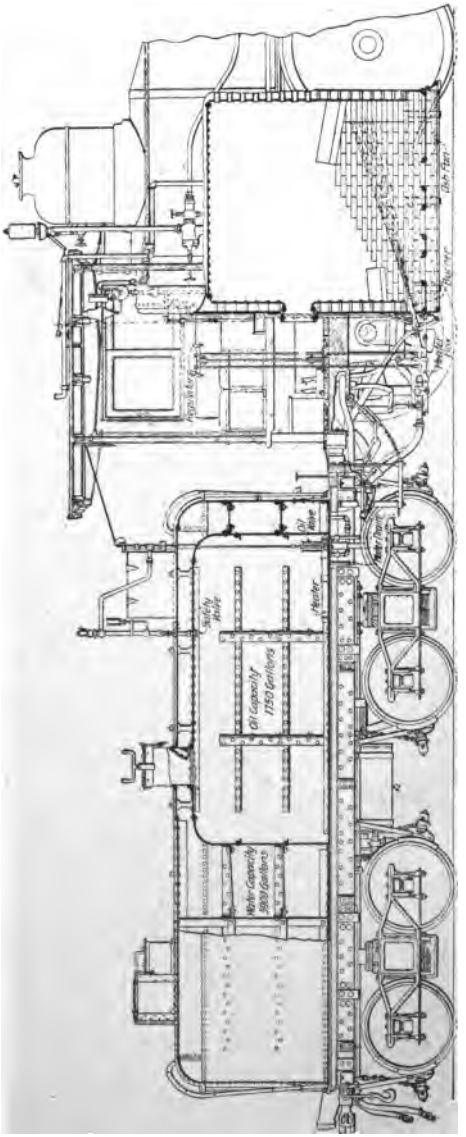
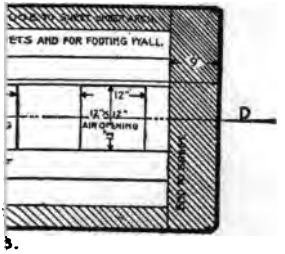


FIG. 12.

GENERAL ARRANGEMENT OF OIL BURNING LOCOMOTIVE—SANTA FE.



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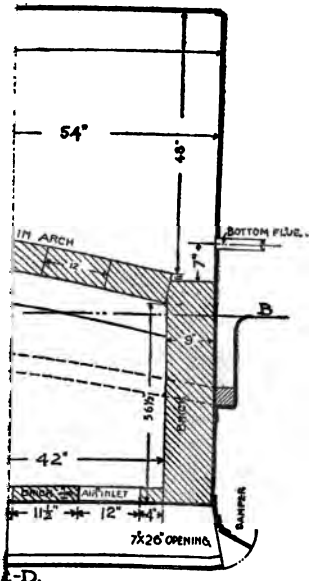

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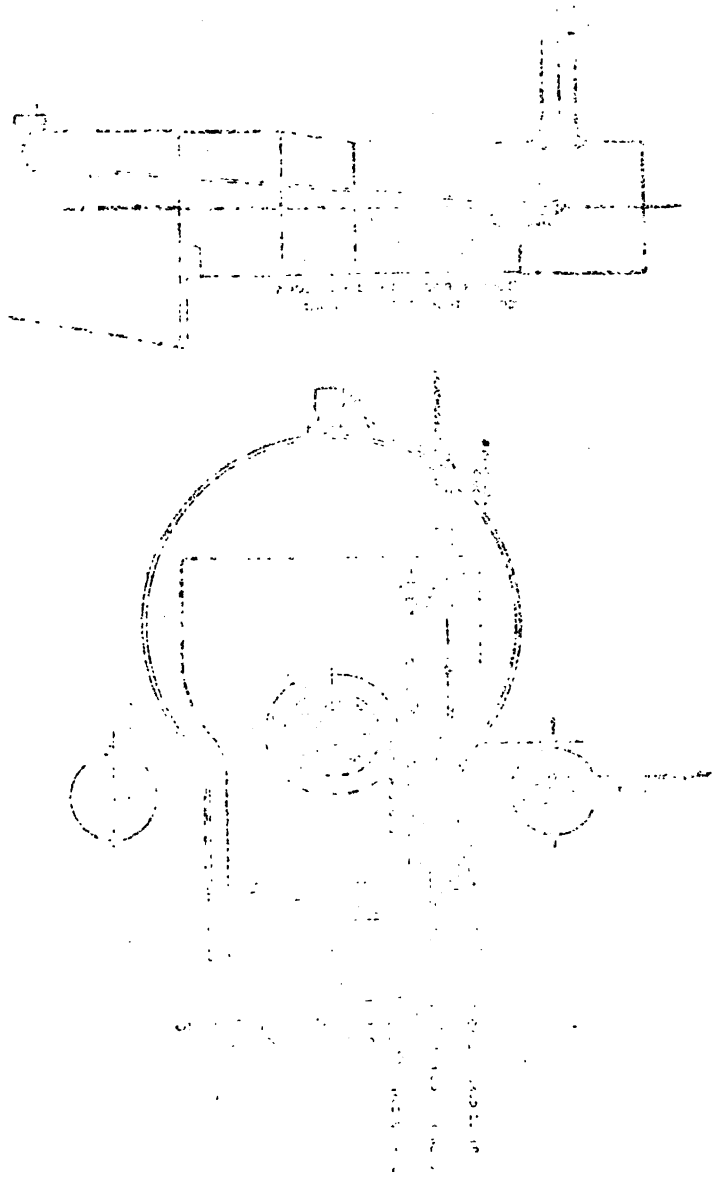


THE LOCOMOTIVE. CONVERTING A COAL BURNER TO AN OIL BURNER. PIPING AND BRICK WORK IN LOCOMOTIVE.

The locomotive shown in Fig. 12 is one converted from a coal burner to oil and shows the position of the different parts of the oil apparatus. In converting a coal burning engine to an oil burner it is necessary first to remove the grates and grate frame and remodel the ash pan by applying a suitable casting fitting the inside of the pan and riveted on the sides and near the top of the pan; this casting acts as a support for the brick work on the sides of the fire box and is cored out to admit the proper amount of air necessary for combustion to the fire box. The brick arch should be built as low as possible, the main purpose of which is to protect the crown sheet, crown bolts and seams from overheating. The oil burner should be secured to the bottom of the mud ring exactly central and should be placed at such an angle that the jet or spray of oil will strike just below or under the arch. Details of the arrangements of piping and brick-work of an oil burning locomotive are given in the accompanying illustrations, (Figs. 13 and 14.)

The details of the fire brick used in the construction of an oil burning locomotive are shown in the drawing, Figure 15.

For the side walls and inverted arch ordinary commercial fire brick is used. Experience has shown that fire bricks which soften under heat are preferable as they form a bond which adds

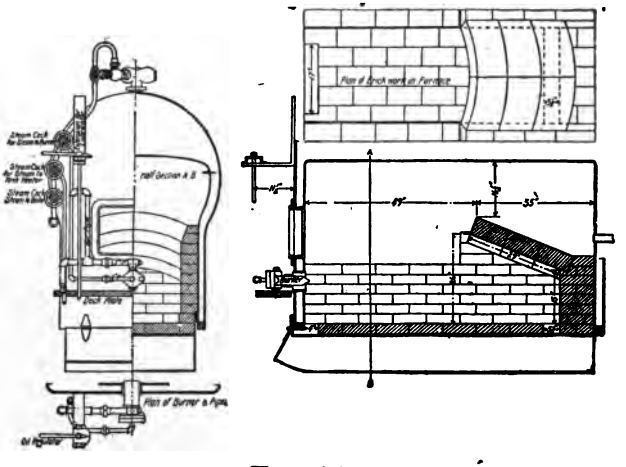


FIG. 14.

FIREBOX EQUIPMENT—SOUTHERN PACIFIC.

strength to the wall and prevents it shattering under the shocks incident to the service. Fire bricks which have very high heat-resisting qualities and which tend to crock when cooling are said to be of little use.

THE BURNER OR ATOMIZER.

One of the principal devices essential to the oil burning locomotive is, of course, the burner or atomizer, of which several designs are illustrated in the following drawings. (Figs. 16, 17, 18 and 19).

The function of the burner or atomizer is to break up the oil into a very fine spray. It is made of brass. In the Santa Fe burner, steam

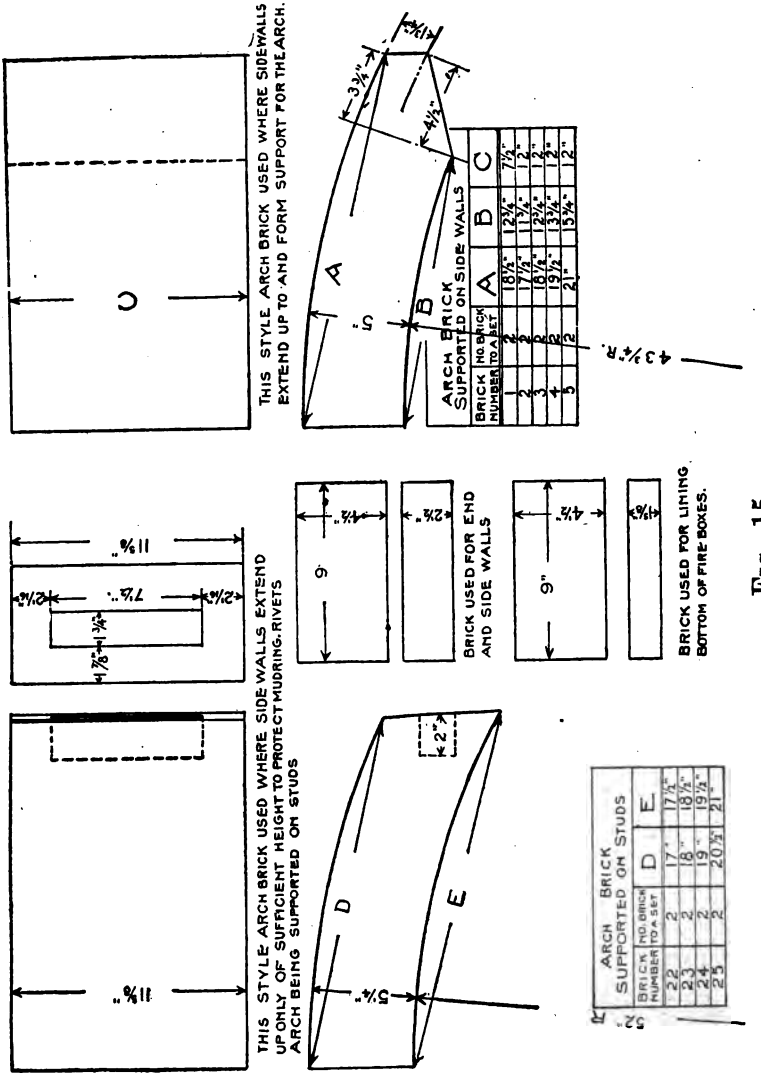


FIG. 15.

DETAILS OF FIRE BRICK—SANTA FE.

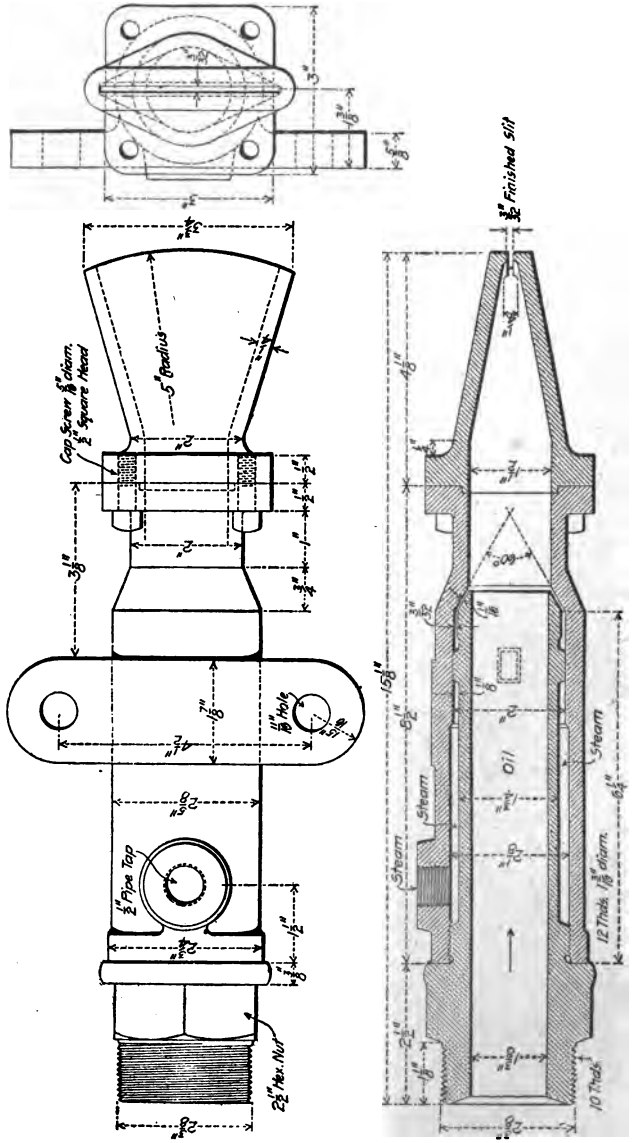


FIG. 16.

DETAILS OF "LUNDHOLM" FUEL OIL BURNER.

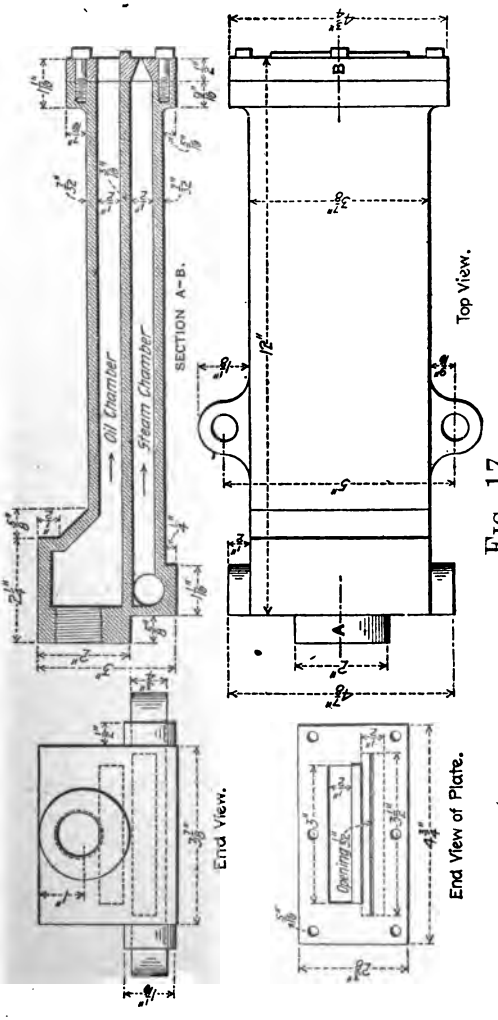


FIG. 17.

DETAILS OF "BOOTH" FUEL OIL BURNER.

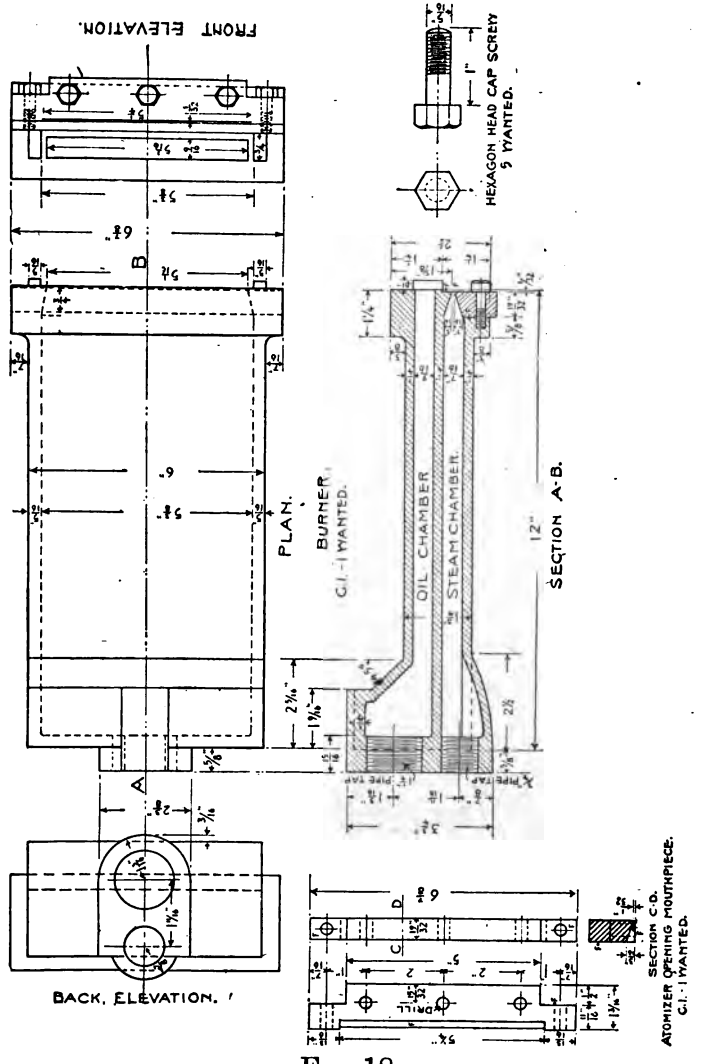


FIG. 18.

DETAILS OF OIL BURNER—SANTA FE.

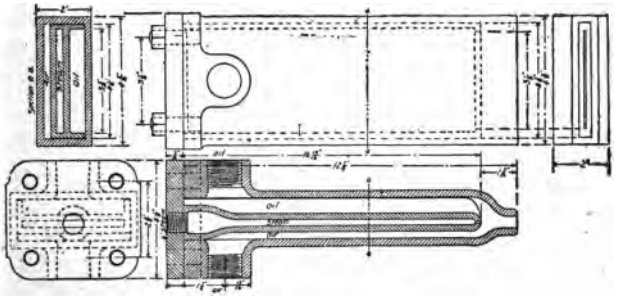


FIG. 19.

DETAILS OF OIL BURNER—SOUTHERN PACIFIC.

enters the bottom part at one end and issues through a slit at the other end. The oil flows through the upper part of the burner over the hot partition and on issuing is caught by the steam and sprayed into the fire, which, when the engine is working, is a mass of flame filling the fire box. The supply of steam and oil to the burner is regulated by the fireman from the cab, the handles of the steam and oil supply valves being located so that he can readily manipulate them from his seat.

The Santa Fe burner is rigidly attached to the mud ring; it is a casting having an oblong passage. One end of the casting is enlarged to receive connection with oil and steam pipes one above the other. The mouth of the steam passage is directly underneath the mouth of the oil passage and the effect of the steam pressure is to spray the oil as it flows from the upper passage.

In the Southern Pacific burner there are three passages: one for oil, one for steam, one for air. The oil enters the rear of the burner from above, air is conveyed from below through a narrower passage to a common mouth just behind which terminates a central tube supplying steam. The mixture of oil, air and steam is there sprayed into the fire box through one nozzle. In the Southern Pacific arrangement the burner is located near the upper part of the bricked portion of the fire box probably for the reason that the form of nozzle causes the spray to be thrown down as well as up.*

THE HEATER BOX.

In order to provide against the effect of cold weather, or where the oil is heavy or lacking in fluidity, a heater box is placed between the burner and the oil tank the purpose of which is to raise the temperature of the oil to as high a temperature as possible before it goes into the burner. The construction of this box is shown in the following illustration, (Fig. 20).

---

*The methods adopted for using oil for fuel have advanced step by step as is the case with all mechanical devices. First came the *Hearth furnace* in which the liquid is thinly distributed in pans or other receptacles and burned; then the *Gas furnace* in which the oil is transformed into gas before combustion, and, finally, the *Atomizer* by which the oil is divided into atoms so that it can be nearly completely consumed in a vaporous condition. The atomizer is the device adopted and used on American locomotives. It is certain however that the final stage has not been reached in the development of mechanical appliances for the combustion of oil.

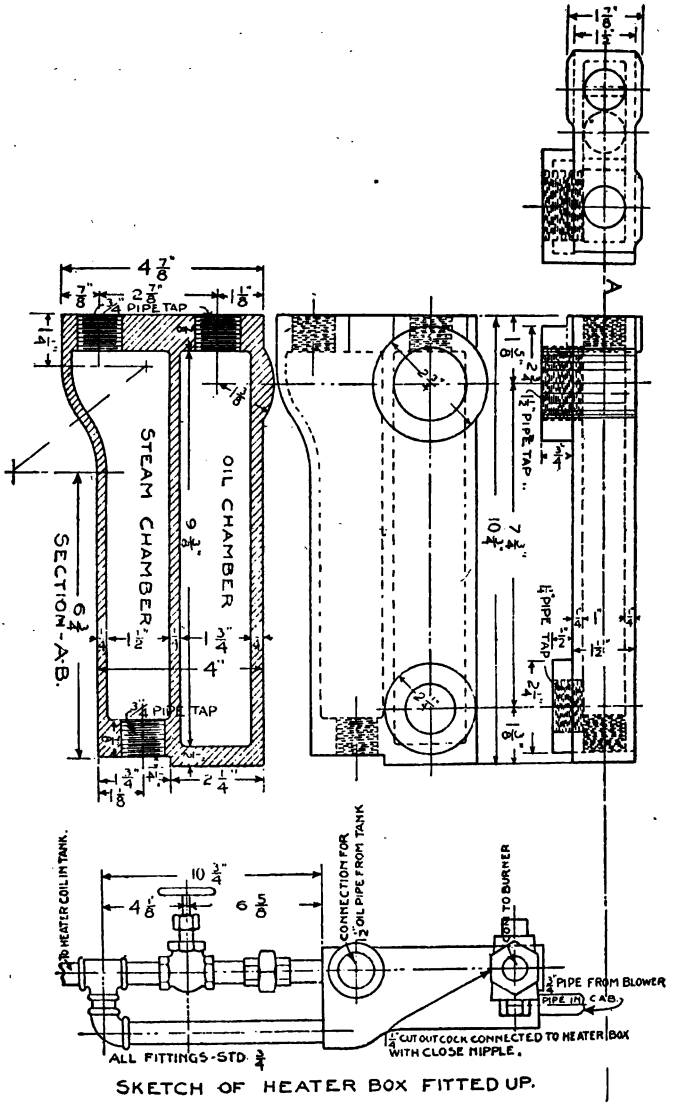


FIG. 20.

DETAILS OF OIL HEATER BOX—SANTA FE.

CAB APPLIANCES.

Detail drawings of the three way cock blower pipe connection to smoke arch and of the oil throttle valve handle are shown in the following drawings, (Figs. 21 and 22).

CLEANING FLUES. SAND FUNNEL.

In the operation of the oil burning locomotive it becomes necessary occasionally to remove the gum and soot generated in the combustion of the oil from the boiler flues. To effect this a funnel is used which is inserted in the fire door through which sand is blown by steam with force, the sand thus blown through the flues carrying with it the accretions of soot. A detail drawing of this funnel is shown in Fig. 23.

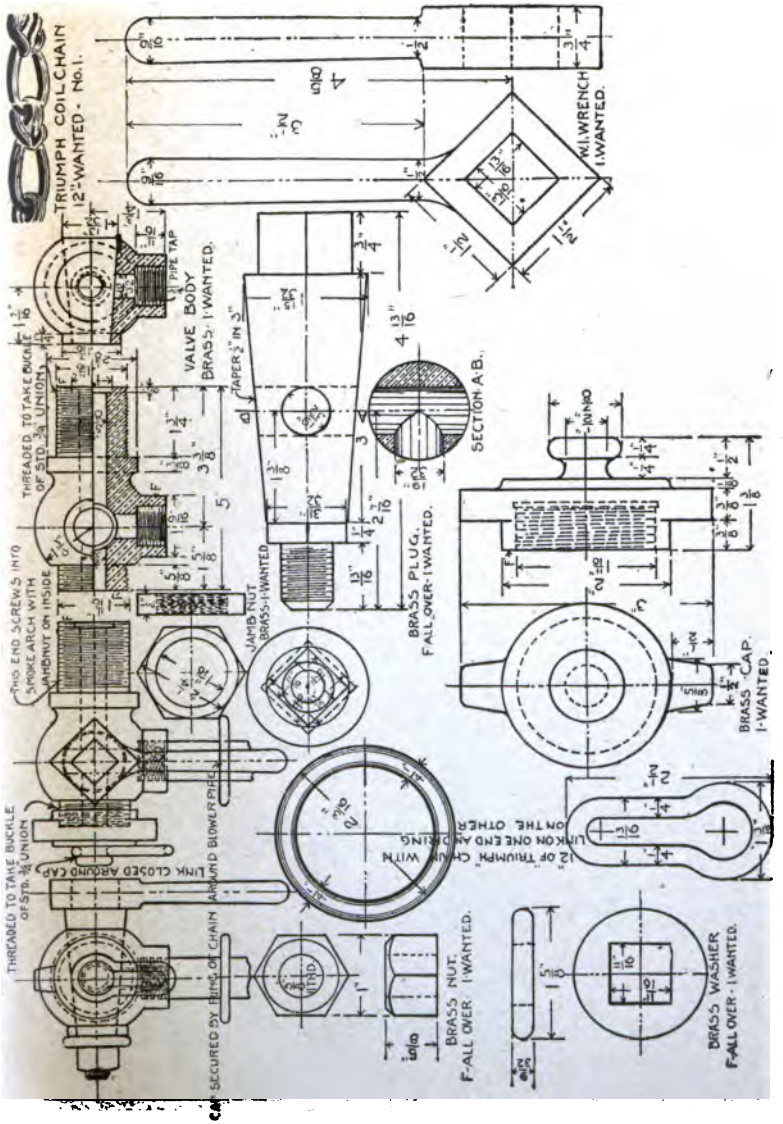


FIG. 21.

DETAILS OF THREE-WAY COCK—SANTA FE.

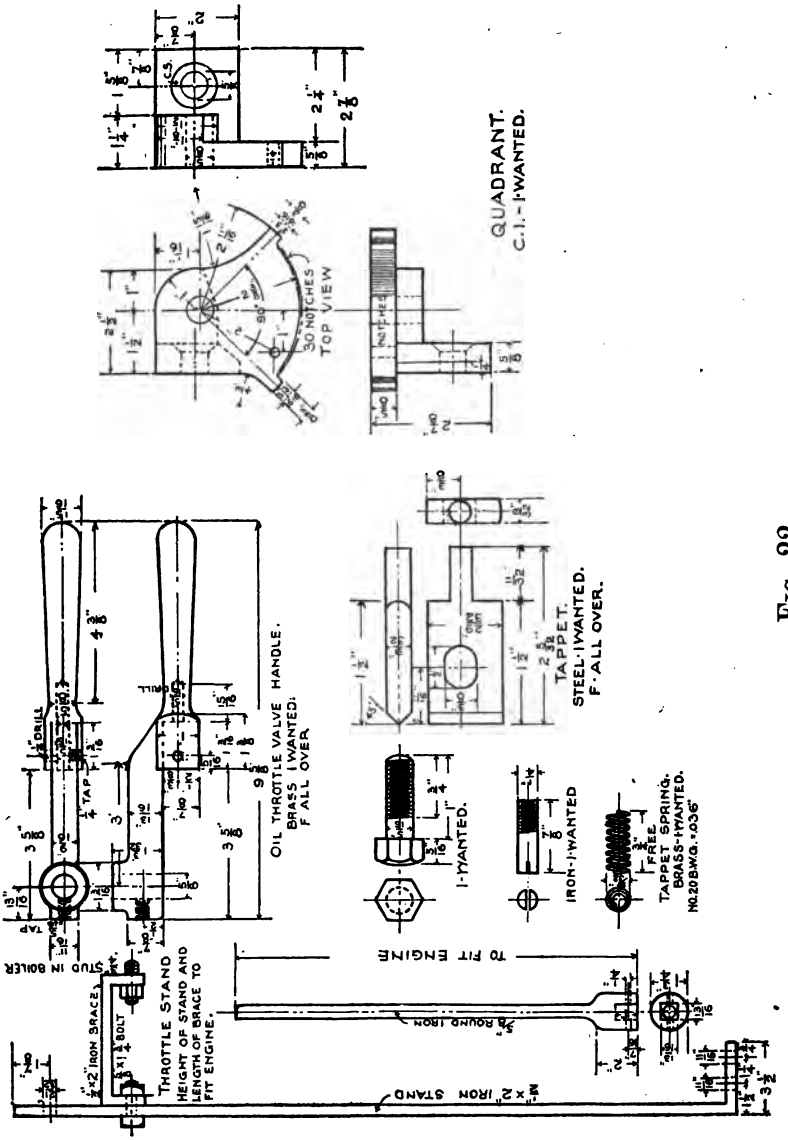
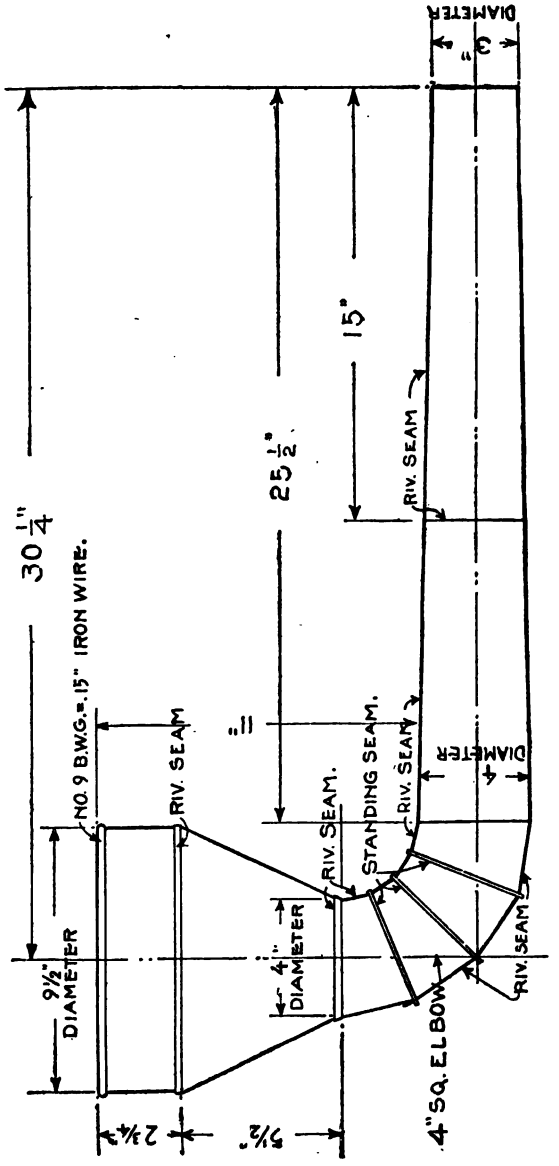


FIG. 22.

DETAILS OF OIL THROTTLE VALVE HANDLE—SANTA FE.



MATERIAL NO. 26 GALV. IRON.
ONE POUND RIVETS.

FIG. 23.

SAND FUNNEL USED IN CLEANING FLUES—SANTA FE.

SPECIFIC RULES TO BE OBSERVED IN FIRING AND OPERATING.

In the operation of oil burning locomotives the following practical rules and regulations have been adopted:

In firing up an oil burning locomotive in the round house steam connection is made to the three way cock on the smoke arch which acts as a blower and atomizer at the same time; then throw in the fire box, in front of the burner, a piece of greasy lighted waist; then start the oil to running slightly; then open the atomizer valve enough to atomize the oil which is flowing from the burner, and the oil will instantly ignite. The fire should be watched until steam begins to generate in the engine, when the round house steam can be cut off. Care should be taken not to turn on too much oil, for the explosion would drive the flame out of the fire box and might be the cause of injury to the operator. Care must also be taken to see that the fire does not go out when first started in a cold engine; if it does and is not noticed the oil will run into the pit and may take fire later on and explode and thus damage the engine. The fire must therefore be carefully watched until its burning is well assured after which there is little danger of this happening. Fire going out on an oil burning engine can be detected readily by observing the smoke coming out of the stack. If it is of a white, milky color, it indicates that the fire has gone out and that the oil is still running out into the

pan; this smoke is caused by the heat of the brick in the bottom of the pan. That the fire has gone out can also be detected by the odor.

In firing up an oil burning locomotive where steam is not available, wood may be used until ten or fifteen pounds of steam is generated in the boiler. The wood must be placed in the fire box with great care so as not to damage the brick work, and in using wood for this purpose care must be taken to avoid causing fires along the right of way or elsewhere.

It is very important that the proper amount of steam be admitted to the burner as an atomizer. It is also very important that the brick walls and arch of the locomotive be kept in perfect condition. Occasionally small pieces of brick will fall down and lodge in front of the burner, which will interfere with the engine steaming. All engines should be equipped with a pair of light tongs or a hook so that the fireman can remove these pieces of brick if necessary.

In oil burning engines it is necessary to occasionally use sand for cleaning the gum off the end of flues in the fire box. This sand is applied through an elbow-shaped funnel made for the purpose; the nozzle of the funnel is inserted through an aperture in the firedoor, and when sand is being applied by the fireman the engineer drops the lever in the corner notch and has his throttle wide open. This is very effective, and is only used three or four times in going over a long hard division.

In handling the oil burner on the road the engineers and firemen must work in harmony,

i. e., when an engineer wishes to shut off the throttle he should notify the fireman in time so that the latter can close the oil valve in order to prevent waste of oil, the emission of black smoke and the "popping off" of the engine; and again, in starting up, the engineer should notify the fireman so that the oil valve may be opened before the throttle, and the fire burning before any cold air is drawn into the fire box by the exhaust. In opening the valve the flow of oil should be gradually increased as the engineer increases the working of the engine. If this rule is carried out it will in a great measure prevent leaky flues, crown and stay bolts. Fire boxes can be easily damaged by over-firing.

In a coal burner if an engine drops back five or ten pounds pressure it takes some little time to regain it; in an oil burner the fire can be crowded so as to bring it up almost instantly and thereby overheat the plates and cause damage to the fire box. The practice should be to consume about as much time in bringing up steam on an oil burner as would be taken with a coal burner; too much care cannot be exercised in this particular. It is possible to melt the rivets off the inside of an oil burner fire box by over-firing.

In drifting down long grades, it is preferable to keep the fire burning a little rather than to shut it off entirely to prevent chilling of the fire box, adjusting the dampers to suit a light fire. The water can be carried in such a way approaching such points as will admit of working the injector occasionally to prevent popping off.

The use of the blower should be restricted all possible. It tends to make the fire box leak. If the blower is used at all it should be used very lightly, simply enough to cause a draught.

Some troubles have been encountered on account of waste getting into the oil tank; these are caused by carelessness on the part of Hostlers and Helpers in measuring the oil and wiping the measuring stick off with waste. Waste should therefore not be used for this purpose.

Do not approach the man hole or vent holes of a tank closer than ten feet with a lighted torch or lantern.

Do not take a lighted torch or lantern to a man hole to ascertain the amount of oil in the tank; this should be done by the insertion of a stick or rod and the same carried to the light to ascertain the number of inches of oil shown on the stick or rod.

Do not, when making repairs to, or inspection of, an empty tank, place a lighted lamp or torch inside of the same before it has been thoroughly steamed and washed out, as gas will accumulate in an empty tank not so steamed and washed out, and explosion is liable. Employes are positively prohibited from entering tanks having contained crude oil, until the instructions to thoroughly steam and wash them out have been complied with.

Do not, in firing up, apply the atomizer and oil before putting in the lighted waste, as gas may accumulate in the fire box and thus cause an explosion.

In starting up or stopping, the engineer must always notify the fireman, as the starting or shutting off of fire must in all cases precede the opening and shutting off of the engine.

Do not force the firing. Bring the fire box temperature up gradually. If pressure falls back five or ten pounds, restore the maximum pressure by gradual degrees. Forced firing will overheat the plates, burn off rivet heads, and cause leaks.

In sanding the flues to clean out the accumulations of soot and gum, drop the lever to half stroke and use full throttle for a few turns, while the sand is being injected.

Successful combustion of petroleum is smokeless.

An accurate combination of steam and oil in the atomizer and air admission is necessary to thorough combustion. To this end the steam and oil valves and dampers must be adjusted closely.

As all petroleum contains a greater or less per cent of volatile gases, which are given off at low temperatures, lighted torches, lamps or lanterns should never be taken in or near tanks containing oil.*

The following rules are enforced by another Company,† viz:

Before departure, see that the oil tanks are full, the oil heater in operation and the oil heated to a proper temperature as soon as possible; also

*The foregoing rules are those in force on the Santa Fe system.

†The Southern Pacific.

that the fire is burning, that no oil is dropping or lying in the outer pan, that no brick or other obstruction to the free passage of oil from the burner to the front wall is lying on the bottom of the inner pan, and that the sand buckets are full.

Starting the Fire.—When the firebox is below igniting point, which is a dull red, open the dampers, start the blower and atomizer medium hard, throw a piece of saturated oily waste, after lighting same, on to the bottom of the inner pan, close and fasten the firebox door, then turn on the oil very light, and see if it ignites at once. If not, shut off the oil at once, and see if the waste is burning. When the oil has ignited, reduce the blower and atomizer to very light feed; also reduce the oil flow until the stack becomes almost clear. In starting the fire by the hot firebox, no waste is used.

Temperature of Oil.—Kern River or thick oil should be heated to from 150 to 170 degrees, McKittrick or thin oil to from 100 to 120 degrees; the temperature should be taken from the measuring rod suspended in the forward tank. Vents on the top of the oil tanks should be kept open at all times, except when tanks are very full and oil is liable to splash out, when they may be kept closed until the oil is reduced from 5 to 7 inches in the tanks, care being taken not to have any lights in the hands when they are first opened after having been closed any length of time.

Heating Oil by Direct Steam Application.—Put the heater on strong until the oil has reached

the proper temperature, then close it off and give it another application. To keep the heater on light and constant might produce water enough in the oil to become objectionable.

Heating by the Coil in Tank.—Open cock on boiler head just sufficient to produce steam water at drain cock under tank. Superheater should be used constantly when weather is anyway chilly. Keep drain cock to superheater open just sufficient to keep cylinder dry.

Starting Train or Engine.—The engine should not be started until the fireman is at the firing valve. Remember that the care of the fire box is as important as keeping up steam or making time. Start the engine carefully, so, if possible, not to slip engine. Open the firing valve sufficiently to make sure that the action of the exhaust will not put out the fire, but not enough to make a great volume of black smoke. Increase the atomizer and oil gradually until full speed is attained, keeping just on the verge of black smoke. When the engine is hooked up, the valves governing the admission of oil should be regulated according to amount required. It is well to use the blower about one-half turn while starting, as this will help to consume the smoke between exhausts and keep the engine hot.

Black Smoke.—Never make an excessively heavy smoke, as it only fills the flues with soot. Soot is a great non-conductor of heat and produces no heat in itself, therefore strive to keep the stack clear at all times except when starting.

Sanding Flues.—Sand as frequently as required, according to the amount of smoke made.

If the engine has to be smoked anyway hard, sand every 10 or 12 miles, but if the stack is kept clear, sand only every 30 to 50 miles. If any amount of switching is done at a station, sand immediately after leaving that station. How to sand: Having attained a fair rate of speed use about one quart of sand, close all the dampers, put the reverse lever near full stroke, open the throttle wide and allow the sand to be drawn from the funnel in a thin stream. Going into a station where stops are to be made great care should be exercised not to cut the oil supply too low before the throttle is closed.

Any draft through the fire box has a tendency to put the fire out; the stronger the draft the stronger must be the oil supply. Consequently there is great danger of the fire being put entirely out before the throttle is closed. When the throttle is closed and oil reduced, the atomizer should be cut down at once, so that it will just keep the oil from dropping onto the bottom of the inner pan, otherwise the intense heat of the fire box will be blown down through the air inlet burning the bottoms of the pans.

Never allow the fire to be put entirely out, except when giving up the engine at the end of a run or when all hands are going away from the engine. Then it must be put out. To put out fire: First close the stop-cock under the tank, allow the oil to all be drawn from the pipe and burner, then close the firing valve, atomizer and all dampers. To blow obstruction from oil line: Close the firing valve, open the cock between

the heater line and the oil line, close the heater line and turn the cock on boiler head to the heater line on full. This will blow all obstructions back into the tank. This arrangement may be used to heat the oil in the tank in case of failure of the coil heater. If any brick from the walls or arches in the fire box should fall in front of the burner, it must be removed at once or pushed to the extreme front of the fire box. Blue gas issuing from the stack is an indication that the fire is out or very nearly so; it is very objectionable and should be avoided if possible, especially on passenger trains.

Burners must be adjusted so that the oil will strike about the middle of the front wall. If the oil drops on the bottom of pan, black smoke and poor steam will be the result. Burners are liable to clog up with sand that is in the oil and by pieces of waste that are sucked up through the air inlet. If trouble is found with it, the inner case or steam jet can be taken out in most cases without disturbing the outer case or the adjustment of the burner. In this manner any obstruction or defect may be readily located and remedied. The blower should never be used stronger than just sufficient to clear the stack of black smoke. Any more is only a waste of fuel and a delay, as too strong a draft through a fire box for the amount of oil admitted only absorbs heat and cools instead of heating the fire box. At water tanks, where it is necessary to keep the injector on all the time the train is standing, the oil supply should be left on a little heavy and the

blower on lightly. This will insure a full head of steam when ready to start. As the oil penetrates the arch brick and causes them to crumble away very fast, it is important to examine the fire box frequently to know its condition. As steam pressure increases on the boiler, the atomizer and blower will work stronger unless they are cut down. Be governed accordingly. Also remember that black smoke is very detrimental to steam generating and that the more that is made, the more it becomes necessary to make.

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